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THIRTY-FIVE YEARS OF RIFLE PRACTICE.

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OF

RIFLE PRACTICE.

1851-1886.

IN SIX PARTS.

By C. D. WESTBROOK,

Late Lt.-Col. 120th Regt., N. Y. S. V., and late Col. and Chief of Staff 5th Div., N. G. S. of N. Y.

PART I.

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PREFACE.

Books have multiplied so greatly, and fresh books are so constantly required to keep up with yearly acquisitions of knowledge, especially in the industrial arts, that a rigid course of selection is enforced upon every reader. Leaving out of view books which are intrinsically worthless, there are so many branches and ramifications of any given subject as to require many different books under the same general title. There are also different classes of readers to whom the same subject must be presented in different ways. Therefore it is that something more than a title is required to convince a reader that he has any interest in a book. Thus a preface is in order.

The rifle engages comparatively a small department of human industry, and one of late development; yet so great has been the power wielded by its aid on the destiny of nations, that all men are called upon to know something of its use. This great Republic is stirred to-day by the danger to which its maritime cities are exposed, of attack by armored vessels and rifled guns owned by insignificant nations, who may even use them for piratical purposes. The lessons of our civil war seem to have been forgotten. After the commencement of that war, immediate demands were made by the Government on a private foundry for rifled cannon, two batteries of which were first introduced into service by the army at the battle of Bull Run. In the navy, at the time of the attack upon Fort Sumter, in April, 1861, there was not a single rifled cannon of heavy calibre, or a single armored vessel. In the language of chief of ordnance Dahlgren, "the millions since spent by the country would not bring back the years that had gone by unimproved, and we went into the conflict like a man picking up the first weapon at hand."

But there is another reason for addressing the public generally. In almost every house there is a fire-arm of some kind, and rifles without number have been scattered broadcast through the country, and are kept on hand ostensibly for the purposes of defense and game, though rarely used for either purpose. The knowledge which is sought to be communicated in this book will enable owners to utilize these weapons, far beyond the original designs of their manufacturers, in healthful recreation and important training, especially for the younger members of the household. Many futile attempts have been made in this country to organize a militia upon whom dependence could be placed to resist

invasion, but could the result be reached to which these pages are directed, a reserve force would be provided, greater even than armed camps could furnish.

This treatise is then directed mainly to the masses ; but, at the same time, manufacturers and experts could doubtless find something to learn from its pages, because they follow a line which has not been taken up in any other work, and embody thirty-five years of experience of an amateur, who has loved his weapon as well as any artist ever loved his pencil, or musician his instrument.

Kingston, N. Y., January 8th, 1886.

C. D. WESTBROOK.

INTRODUCTORY CHAPTER.

ALTHOUGH more than three hundred and fifty years have elapsed since the discovery of rifled fire-arms, yet it is within the last thirty-five years that improvements were effected in their use, which have made them not only the arm of all nations, but the only arm, whether small or great, on which reliance is placed.

It is worthy of remark that these improvements have been mainly attained through the cartridge; for, although the quick twist and shallow groove of the modern rifle are undeniable advantages, yet the former was not wholly unknown at the commencement of the period alluded to, while, in regard to the latter, it may be said that long range and accuracy had been obtained prior to its adoption. The brass cartridge, lengthened projectile, and large charge of powder, sum up, in a few words, the chief improvements which have been made. By their use, the breech-loader has been transformed from a nuisance to be the king of arms.

We may follow these improvements, as they have been developed in European practice, from the bullets of Delvigne and Minie, to those of Whitworth, Jacobs, and Metford; and, indeed, it will be necessary so to do in the course of this treatise; but it is the writer's intention to deal mainly with the results of American practice, as they have come under his own observation and experience, during the last thirty-five years. As many of the most important of these results have not been placed upon record, with a statement of the means by which they have been attained, it has been deemed proper, at this time, to offer them to the public.

Again, great as have been the results obtained by the use of improved weapons, during the European wars of the last

decades, still greater are the possible achievements in warfare offered by the experiments of the four years which have attended and followed the international contests, with military rifles, between this country and England. The needle-gun, which so materially assisted Germany in her conquests, together with the Mauser, which subsequently replaced it; the Peabody Martini, which astonished Europe with its long range and deadly slaughter in the Russo-Turkish war, and the Martini-Henry, which so easily vanquished larger opposing forces of Egyptians and Arabs, would prove to be almost puerile weapons, when pitted with the cartridges they then used, against the same weapons it may be, or certainly against many weapons which have been in common use for years, when supplied with the cartridges which can now be furnished to them.

The improved shooting of the champion military rifles at Creedmoor justifies this inference. Their methods of loading, however, are not upon record, and the public very generally believe that the excellent shooting, of which they hear, is due to the use of a rifle of superior excellence, or to a training through years of experience, aided by exceptional natural advantages. Such was, undoubtedly, the view taken by the public of the extraordinary performances of the match rifle teams sent to Ireland some ten years since. But subsequent experience has convinced hundreds and thousands that equal, and even better shooting, was attainable with rifles, furnished by a score of manufacturers, with factory cartridges. To obtain such shooting, however, with self-loaded cartridges and self-fabricated bullets, is not quite so easy; and to turn these elegant match rifles to practical use, or to obtain practical shooting, for the sportsman or soldier, of equal nicety from them, or from sporting or military rifles, seems to be out of the question altogether, to the public generally. And yet it is hoped that, from a perusal of these pages, such results can be attained.

We have alluded to two international contests between this country and England. The first was in 1877, when match rifles were used. The second was in 1882, and again in 1883, when military rifles were used.

The difference between these international contests is not well understood.

A discussion of this difference now, though chronologically out of place, may serve to clear up some difficulties, and secure a closer attention to historical details throughout this treatise.

In the former of these contests we were victors, and in the excellence of our weapons and the superiority of our marksmen, still continue to hold the championship of the world. In the latter, we have been beaten by England; and the reason simply was that we had cultivated the match rifle and neglected the military rifle. In England, military rifles have always received the chief attention.

Leaving out, for the present, the definition which is given of these rifles at Creedmoor and Wimbledon, we will take them up in a non-professional way.

In the first place, there is a specific difference between these rifles; and in the next place, there is a still greater difference between the methods of using them.

1st. Although the weapons do not vary more than half a pound in the weight to which they are restricted, yet, in the match rifle, there is a maximum of weight in the barrel and a minimum of weight in the stock, leaving the latter, particularly in its connection with the barrel, of too light a weight safely to endure the shocks of military usage. For the purpose of fine sighting, it has also so large a bulk of material on the end of its barrel, for its forward sight, as to prevent the proper clasp of the bayonet, while its long and slender back sights would not long endure military usage.

Per contra, we have in the military rifle, stocks sufficiently strong for military purposes, which permit the use of a sling, and extended over the length of the barrel, nearly to the head of the bayonet, providing for the carriage of both sling and ramrod, and protecting the hands in the use of a heated barrel, which was of more consequence while muzzle loading was practiced than at present. The pull of its trigger is to be double that of the match rifle, and its sights to be of *bona fide* military pattern, to be attached to the barrel, and to be without any movable attachment other than a hinged flap and sliding bar, to be moved by hand only.

Although the barrel of a match rifle will spring under the concussion of the heavy charges used in modern cartridges, yet, paradoxical as the statement may appear, the spring

which it has under the concussion of firing is a real advantage over the performance of a heavier rifle in the contests of the range. As this statement needs explanation, for the comprehension not only of the public, but also of a great many marksmen, it is well to clear up the matter before proceeding further with the comparison of match with military rifles.

If we examine the back sight of a match rifle, we shall find it marked with sub-divisions, which almost universally are one of only two kinds. It is either marked with twenty divisions to an inch, which is multiplied by a vernier attachment to one hundred divisions of the inch, or else it is marked by degrees and minutes, which, if the back sight is placed upon what is called the tang (which is not far behind the lock of the gun, and three feet distant from the front sight), would represent pretty accurately the angles of elevation. The marks upon the sight are for every five minutes of elevation, reduced by the vernier to every minute of elevation.

Thus, in the one kind of back sight, we have practically 100 sub-divisions to the inch, and in the other we have somewhat over 90 to the inch.

Now, either of these sights, whether standing upon what is called the tang of the piece (which places it about three feet from the front sight), or whether fastened upon the butt of the piece (which is almost four feet from the front sight), has an actual value of elevation upon the target, at any distance, from one to one thousand yards, or more, which is readily calculated.

For instance, the sight upon the tang which is marked with hundredths of an inch, would have the value of elevation, for each hundredth, at 100 yards, of one inch, and at 1,000 yards of ten inches. Each minute of the other sight would have a value of elevation upon the tang of 1.05 inches at 100 yards, and $10\frac{1}{2}$ inches at 1,000 yards.

Now, the owner of a rifle will seek, by experience, to find the number of marks on the back sight that will correspond with the elevations required to hit the mark aimed at, for various distances. For, although he will find a table given by the manufacturer or (more correctly still by the Metford tables), for a given weight and quality of powder, and a given

weight of bullet, which tables will correspond, with considerable accuracy, to the performance of different rifles of the same calibre, owing to the uniformity of trajectories of different rifles; with like weights and quality of powder, like weights of bullets, and like calibres, each rifle will have its own reading, which will vary considerably from other rifles similarly conditioned, as to these weights and calibres, for the following reasons:

First. The sights, though made as nearly alike as is possible to construct them, may be placed at varying elevations on the stock, which, of course, would vary the elevation of the zero point, or starting point, of the marks upon the sight; because, usually these zero points are marked on the sight before it has been placed upon the barrel.

Moreover, as this zero point will be found to be constantly changing, from different charges of powder and different weights of bullet, the only inducement to leave it unmarked upon the sight, until found by firing the piece, would be the desire to use the piece with a fixed charge, and for a fixed purpose.

Secondly. Supposing two rifles to be made exactly alike in their proportions and sights, and alike in the trajectory of their bullets, it will be found that, owing to the different spring of their barrels under the concussion of fire, their sights will read differently in actual practice. We are now engaged with our explanation of the fact of this spring, and, therefore, have run into a little obscurity by begging this question, which will be dissipated as we proceed.

We now assume that the owner of a rifle is acquainted, from experience, with the number of marks upon the back sight, which will give him the necessary elevation at varying distances.

If now he will fix a long-range match rifle in a vise, aimed, we will say, at a mark 100 yards distant, and then open the breech and look through the barrel, he will find that aimed at a much higher elevation. Indeed, it should be aimed higher (we will assume it to be ten inches) to allow for the fall of the bullet by gravity; but he will find it to be aimed very much higher than that. Whatever he may find the height to be, in so far as it exceeds ten inches, it will be owing to a spring downwards of the barrel in the concussion of firing.

This spring would not always be downwards for different lengths of barrel and quality of charge, but for all long range match rifles, under the rules of the range, it will be found to be uniformly downwards, though varying somewhat for different rifles.

For instance, the writer is the owner of a match rifle, that, with a charge of 60 grains of powder and 325 grains of bullet, will hit the mark at 100 yards with 13 minutes of elevation at the tang. The same rifle, with the same bullet and same quality of powder, will, with 115 grains of the latter, require 25 minutes of elevation to reach the same mark at the distance of 100 yards; the extra quantity of powder having caused the barrel to spring, apparently, 12.60 inches downward in the distance marked upon the target, but really about 17 inches, owing to the greater velocity and flatter trajectory of the larger charge.

Now, at 200 yards distance, the first charge will require 25 minutes of elevation, and the latter 34 minutes. At 400 yards, the bullets will meet upon the target from the same reading of the back sight. Therefore, an increase of the charge from 60 to 115 grains, with a bullet of 325 grains, will make no difference on the target at 400 yards, although, at 100 yards, they gave a difference of 12.60 inches.

Again, the same rifle, with 105 grains F. G., Hazard powder, and 550 grains of lead will require a reading of 35 minutes of tang elevation, and of 45 minutes at the butt, to reach the mark at 100 yards of distance. With the same bullet and the same quality of powder, but with 115 grains instead of 105, it will require 49½ minutes of elevation at the butt to reach the mark at the same distance—100 yards. At 500 yards, the smaller charge will require 102 minutes, and the larger charge 104 minutes; but at 800 yards, both charges require an elevation of 157 minutes. At that distance, 105 grains and 115 grains of powder, with 550 of lead, require the same elevation exactly; so that any variation of powder, by inexact measurement, or any other cause that will give an increased or diminished velocity to the bullet, will cause no appreciable variation between these extremes; but a variation in the charge, below 105 grains of powder and 550 grains of lead, will show an appreciable variation at the target, so that a variation of 25 grains, below the quantity

which has been mentioned, will give a variation at the target, by the inexact measurement of a single grain of powder, of many inches.

With another match rifle of the writer, the extremes of 110 grains and 120 grains of powder, with 550 grains of lead, will meet the target at 1,000 yards.

Thus the elegant match rifles which, at 800, 900 and 1,000 yards, have obtained such fame at Creedmoor, are really better weapons at those distances than those made with heavier or lighter barrels. And the reason of the advice given by experts—"Find, by experiment, the quantity of powder that your rifle will bear, by increasing the quantity used, so long as it will give increased elevation; then add a few grains, and you have found the charge for that rifle"—is made apparent.

The second point of difference between the match rifle and the military rifle has reference to different methods of shooting.

In the first place, the shots from a match rifle are delivered from an absolutely clean barrel, and for that purpose cleaning the barrel must be resorted to after every shot. It is true that the Fisher wiper has very much curtailed the time necessary for this performance, so that a large number of shots could be probably delivered as effectively from the match as from the military rifle, because the time taken for the cleaning of the piece would be compensated for by the reduction of heat in the barrel; yet the use of a ramrod and water, for this purpose, is incompatible with military exigencies. The military rifle must be fired rapidly, without the encumbrance of loose ramrods or other adjuncts. A rapid fire, for a few minutes of time, is all that is generally required for a military rifle; but that rapidity is an essential qualification. It cannot, therefore, be cleaned between shots.

2d. The cartridges of match rifles do not generally contain the bullets; or, if they do, the bullets are very lightly inserted, and the cartridges will not endure, without injury, the rough transportation of military service.

The difference in accuracy between these two classes of weapons, previously to the international contests of military rifles, was about twenty-five per cent., in favor of the match rifle, at long range. At the close of these contests, it had

narrowed down to fifteen per cent. At the present time, it is certainly less than ten per cent.

Previous to the international contests, the bullets and charges of powder used in military were less than those used in the match rifles. The Government cartridges of the Springfield rifle contained 70 grains of powder and 405 grains of lead. The Remington and Sharp military rifles, used on the ranges, were bored to take the same cartridges. The bullets were unpatched and cannulared, and the grooves filled with grease, to diminish the friction, soften the residuum and prevent the barrel from leading during continued fire. The bullets also were larger than the bore of the piece. The military range, for accurate fire, was not over 600 yards with these cartridges.

England, however, for fifteen years, had been using in her army rifle a cartridge with 85 grains of powder and 480 grains of lead, with a smooth and patched, instead of a naked cannulared bullet. The bullet was not dissimilar to that used in the match rifle, and the practice with it had been at 1,000 yards. This bullet, like the unpatched one, was reduced in size at least $\frac{10}{1000}$ of an inch in passing through the barrel. The lubrication was effected by greased wads.

In the progress of improvement, it was found that this swaging was wholly unnecessary, and was detrimental, from its friction, causing increased recoil, and diminished range and accuracy. The deep grooves of the rifle, which had rendered this swaging policy necessary, were found to be much inferior in performance to a shallow groove, with a harder bullet; and these shallow grooves and hardened bullets, with a barrel approximating to that used in the match rifle, were the main features of the special military rifles which made such splendid performances in England, as long ago as the year 1878. In them was also used a heavier bullet (in fact, the same as was used in the match rifle), and, in many instances, a larger charge of powder.

Such were the rifles with which we were confronted at the first national military contest with England. We hastily improvised some military specials, by using the match rifle barrel, and attempted to adapt to them military cartridges. The rifle was all that was required, but the cartridges were failures, and we were badly beaten, because unprepared.

The next year found us better prepared; in fact, to an extent which promised, to public anticipation on this side of the water, a victory. But we were again beaten, simply by failure at the extreme ranges.

It is profitable now to follow the improvements that were introduced. In the first contest, the rifles used had been prepared by the Remingtons, with a large shell, which, in the second contest, was, as we shall attempt to show, unwisely exchanged for a smaller one, the reasons for which opinion will shortly appear.

In the first contest we depended upon greased wads for lubrication; these, as we now know, were inadequate. In the second contest we depended mainly upon the breathing-tube, for moistening the residuum of powder in the barrel, thus removing hardened obstructions and lubricating the barrel.

The rifles supplied for this contest were from two sources—four from Remington, and eight from Brown. Both were bored for shells with the capacity of 106 grains—straight shells, $2\frac{6}{10}$ inches in length.

The former used 76 grains of ducking powder, retaining the wads, which filled the rest of the case. The latter used 105 grains of Hazard, F. G., with an apology for a wad—*i. e.*, a paper wad soaked in some preparation. Both depended mainly upon breathing tubes.

The men and rifles were all that could be desired. Indeed, the contest gave some evidence of their superiority. But they were found defective at long range, as it was alleged, from want of sufficient practice. This may have been the reason at that time; but the writer will attempt to show that, had those men been supplied with proper cartridges, they would have exhibited unquestionable superiority to their opponents.

The difficulties with the Remington cartridges were in carrying too small a quantity of powder, and powder not of the right kind.

In support of the first allegation, we refer to what has been already stated, as to the necessity of loading the rifle with a charge sufficiently heavy, so that the addition of five or more grains will show no appreciable effect upon the target. Thus, variation from inexact measurement of powder,

from want of uniformity in its packing in the shell, or from crushed powder, or any other cause which would increase or diminish velocity and recoil, would have been in a great measure removed. The objection to the quality is the quickness of its explosion—a minor fault, which will not be discussed at present.

The difficulty with the Brown cartridge was the want of a sufficient wad, to prevent the collection of quantities of residuum which would escape the compensating action of the breathing tube. 105 grains of Hazard's F. G. powder may be sufficient for the shell; but to carry a wad of sufficient size, to have been effective, would have required a larger shell.

But experiments, followed up since the contest, have demonstrated the possibility of using a smaller quantity of powder to gain the same propulsive force, and at the same time secure cleanliness to the barrel, and a sufficient, and, indeed, superior, lubrication to that afforded by grease. The use of three grains, by weight, of wood powder, at the bottom of the shell, and 100 grains of black rifle powder overlaying it (which requires the same room in the shell as 110 grains of black powder), will give a propulsive force of 120 grains of black powder. This quantity is all that is required for the nicest performance of the rifle at 1,000 yards.

The $2\frac{6}{10}$ shell, however, will not contain this quantity of powder, and insert the bullet two-thirds of its diameter, without packing the powder to a deleterious extent. Moreover, the wad, which is an essential part of the cartridge, and which should also provide a proper solvent, must be left out.

Here we will leave this discussion, again to be taken up at a more advanced portion of this work, and consider in order the improvements of rifle practice for the last thirty-five years.

For assistance in this work, and for greater accuracy, a long list of treatises has been consulted, prominent among which are the books of Chapman, Cleveland, Wilcox, Norton, Jervis, Wingate, Perry, Laidley, Weston, Greener, and Reports of Army and Navy Bureaus of Ordnance, of the Patent Office, and of the New York Spirit of the Times; from all of which quotations have been made.

CHAPTER I.

RIFLES ANTERIOR TO OUR CIVIL WAR.

It is now nearly thirty-five years since the writer came into possession of a rifle constructed by Edwin Wesson, of Northboro, Mass. There are yet many living who remember the wonderful advance in range and accuracy secured by these Wesson rifles, and those manufactured by James, of Utica; Lewis, of Troy; Fish, of New York; Billinghurst, of Rochester, and others whose names are too numerous to mention here. All of these rifles, however, were indebted, for their efficacy, to their use of the flat-ended picket, or elongated bullet, and loading muzzle, patented by Alvan Clarke, of Cambridge, Mass., on the 24th of April, 1840.

Before Delvigne had patented or Minie applied the elongated bullet, Clarke had preceded them, as it was more than a year afterwards, *viz.*, in June, 1841, that Delvigne obtained a patent for his elongated bullet in France. Moreover, it was found impracticable to use this bullet in the Delvigne model rifle of 1842, for which it was designed, and the spherical bullet, which was then in universal use, and which had been previously used in the Delvigne rifle, so long ago as the year 1830, in its first issue to the Guard Royal in the Algerian campaign, continued to be used until the pillar or tige of Thouvinen was applied in the model of 1846, under the name of the tige rifle, when the elongated bullet finally became successful in France. In June, 1849, at a competitive trial at Vincennes, the tige rifle and bullet were beaten by a rifle without the tige, and by a bullet of M. Minie.

The winter previous to the writer's possession of a Wesson rifle had been passed in the city of Montreal, where he frequently accompanied the proprietor of the hotel in which he boarded, on his daily visit to the building erected on the ice of the St. Lawrence River, where the Rifle Club of Montreal were practicing for their annual competition. The proprietor was an American gentleman, and also a member of the Rifle Club of Montreal—of which he was the only one that was in possession of an American rifle. The other members used English rifles, with a spherical ball, surrounded with an annular projection. They were practicing at twenty rods, while the American was practicing at sixty rods, and the

latter informed the writer that it had been proposed in the club—against which he was strenuously protesting—to shoot at these odds, at the annual contest, on the ground that they represented the actual difference between the rifles.

The rifle used by the American had been manufactured for him by James, of Utica, after he had tried and failed to get one of Wesson's rifles, who, as he informed the writer, made the best rifle that could be procured.

The writer then remembered that he had been offered a Wesson rifle, at Portland, Me., during the previous summer, for which he went at once, on his return, to Portland. The owner, however, had died, and his widow lived at Bangor, and so it was the next summer before the rifle was finally procured. The writer well recollects his astonishment when it was tried on the farm of a friend, at Gorham; and it is well to remark here, that the performance of the Wesson rifle thirty-five years ago has never been surpassed, as to accuracy, in any distance, up to forty rods, although a greater range was obtained by heavier barrels and bullets, constructed on the same principle, before the war of the rebellion.

It was in 1841 that Wesson began the manufacture of his rifles at Northboro, Mass. At that time, the shortest string of the old rifles, at 40 rods, was 50 inches. After the introduction of his rifles, a 20-inch string, at that distance, was common shooting. With a rifle made by James, Mr. J. T. Chapman, author of a work on the improved American rifle, made a string of $13\frac{5}{8}$ inches at 40 rods. At a sporting match in Sherburne, N. Y., in January, 1845, the prize was won by a three-shot string of $3\frac{5}{8}$ inches at 40 rods. The best strings which have been made by Chapman, at 40 rods, were 12 inches with a James rifle, and 11 inches, at the same distance, with a Wesson rifle. With a James rifle, at 40 rods, using a telescopic sight, he has made a string of $9\frac{5}{8}$ inches, averaging less than an inch of variation to each shot.

The Wesson rifle owned by the writer weighed $13\frac{1}{2}$ lbs.; the weight of its barrel was 10 lbs.; it had open, globe and telescopic sights, loading muzzle, chamber bushed with platinum, movable wind-gauge on forward sight also graduated on platinum and cut with an index of $\frac{1}{32}$ of an inch; the bead stood about $\frac{3}{16}$ of an inch from the barrel, and was

shaded by a hood of $\frac{3}{8}$ of an inch in diameter and one inch long; the barrel was of cast-steel, annealed, and 32 inches long, about 38 in its calibre, and cut with a gaining twist, commencing with one turn in 6 feet, and ending with one in $3\frac{1}{2}$ feet, with 6 grooves, and the sides of the lands cut square to their face, and the grooves not quite so wide as the lands. The ball was conical, of 240 grains in weight, and used with a charge of 75 grains of Hazard's sea-shooting powder. The globe sight was turned with a screw of 64 threads to an inch, which marked the declination of the ball as 1 foot in 20 rods, 4 feet in 40 rods, 13 feet in 60 rods, and 24 feet in 80 rods. There was no spring in the barrel under the concussion of firing, as may be observed in the Creedmoor rifles of the present day, and a touch to its hair trigger would send a bullet, wind and weather permitting, into a previous hole at 100 yards. The writer has actually fired, from a rest, seven successive shots in the same bullet hole (making a slightly curved line of $1\frac{1}{2}$ inches in length), from a distance of 173 yards.

There were faults, however, in the performance of the rifle, in occasionally overturning the bullet. The general idea seemed to be that this happened from a fracture of the hold of the bullet in the grooves of the rifle. The recovery of some bullets which had been fired, however, taught the writer that the ribs of the bullet had been melted, as he found a drop of lead, thus melted, on the forward part of the bullet, which had been one of its ribs. This discovery, exonerating the twist from the blame of deforming the ball, was the basis of subsequent experiments to increase its velocity, which, at that time, however, were only successful at the expense of its accuracy. The fear of a rapid twist was then, and even now is, a bugbear in developing the performance of a rifle.

The patchin of the ball was a circular piece of linen, about twice its diameter, wet with spittle when designed for immediate firing, and grease when used for hunting, which was laid flat on the loading muzzle, the flat end of the picket standing on its centre, when the guide starter would be put on, embracing the false muzzle. The bullet would then be driven into the grooves of the rifle, surrounded by its fold of linen, passing through the false muzzle into the rifle a distance of several inches, according to the length of

the starter, whose flat top would be driven by a blow of the hand. In the false muzzle the bullet would take the grooves, and pass below the grip of the true muzzle, which extended only an inch and a half from the entrance, from which point the bore was freed or enlarged to the chamber of the rifle, so that the bullet glided easily down to the powder. The removal of the false muzzle left the grooves in the true muzzle sharp and clear to the exit of the bullet. To this fact the superiority in accuracy of the rifle loaded with a false muzzle is attributable.

A more efficient covering of the bullet completely protected it from the heat of the gas, and by enabling it to retain its hold upon the grooves, permitted the use of larger charges of powder, and more effectually blocked the escape of gas through the grooves of the rifle, which were much deeper than those used at the present day. The writer was engaged in these experiments at the outbreak of the rebellion, and before their completion was called upon for active service in the field.

But, postponing at present a detail of the improvements which had been made, at the commencement of the war, in rifles and their projectiles, the writer returns to historical narrative of little incidents which, though unimportant in themselves, will serve better to elucidate rifle practice than more scientific discussions bristling with trajectories and algebraic formula.

The writer was in possession of his long-sought rifle, and had returned to his temporary residence at Guildhall, Vermont. On the next morning, after breakfast, looking over the wide square which fronted the hotel, to the hill beyond, some fowls were seen at a convenient distance, the ownership of which was assumed by the fat landlord, who was sitting in an easy chair, smoking his pipe. In answer to a request for a shot at a straggler, the writer was given permission to shoot all day at that distance. Balancing the rifle on a chair, the shot was made, when immediately the usual gyrations of an animal from a mortal wound were visible, and the result of the shot as quickly announced by a spring of the fat landlord from his chair, with the exclamation, "You have shot her!" A measurement was shortly made, from which the distance was found to be 123½ yards. The shot gathered

some of the leading men of the village, who pronounced it a chance shot. The village merchant proposed to put up chickens, at 100 yards, for sixpence a shot, while the village doctor would put up, at 40 rods, the largest turkey in the county, at ninepence a shot. These propositions were all accepted, and in due course of time, the parties appeared with their birds. The first chicken, at 100 yards, was missed, which miss was followed by a peal of laughter from the crowd, and a bystander offered to bet a box of cigars that the next shot, also, would be a failure; which proposition also was accepted by the writer. The second shot secured the chicken, as did also the succeeding ones, consecutively, until six chickens had been scored. The merchant then pleaded that he had lost enough. Upon a call for the turkey, the doctor made his appearance with a thirty-two-pounder, with which he proceeded to the requisite distance, and, with true Yankee ingenuity, tied him with his body behind a fence post, on the top of which his fan-like tail was spread. No fence post of timber, however, grown in that country, was proof against the bullet of a Wesson rifle, nor was any large enough to hide the body of that turkey. The doctor brought him back, after the first shot, a *corpus delicti*, upon which the whole party subsequently dined.

A few days afterwards, a flock of ducks made their appearance in the Connecticut River, near the New Hampshire shore. The writer fired a shot at them, from a distance of about 100 yards, selecting a group of three who were in line. Two of the ducks remained dead in the water, while the third was observed to fall from the flock at a considerable distance. This shot, which was observed by others, and talked over, induced an old gentleman, who had been a notable shot in his day, to propose to the writer that he should shoot at a dollar, put up at 100 yards, at ten cents a shot. Accepting the challenge, without any doubt as to the result, the writer was victimized by a target fastened to the edge of a lath, laid horizontally, with a back-ground of snow, which rendered it invisible. Subsequently, however, the old gentleman was equally victimized, by putting up a dollar bill, to be shot at on the same terms, at 60 rods, pasted on the middle of a nine-inch bull's eye. As the target was on the ice of the Connecticut River, and a gale of wind was blowing

at the time, he supposed his venture was reasonably safe. Two shots, however, out of five, would win the prize, until the old gentleman was satisfied.

In the course of time, the scene of the writer's employment, and amusement with his rifle, shifted to the west, in the State of Wisconsin. Shortly after his arrival, thirty or forty wild ducks were killed by his rifle, on the suburbs of a village, with many spectators. At another time and place, a partridge was killed, from a tree, more than 100 yards distant, in the presence of several spectators. In answer to the suggestion that it was a chance shot, a mark was put up at 200 yards distant, at which off-hand shots were fired with a hair trigger, which averaged about three or four inches from the centre. A match was then spoken of, with a tige rifle, which had recently been brought from Europe. The match did not come off; but the same tige rifle was subsequently used by the writer, for shooting in the woods, for which purpose, from its light weight and easy loading, it was handier than his Wesson rifle. Its accuracy, moreover, was sufficient to bring a squirrel from the loftiest trees, a fact which rather surprised the writer when he heard, about the same time, of the Minie rifle, that was superseding it, with a range of 1,100 yards, and when the published trajectories of both bullets came under his observation, at a later date, and failed to confirm his expectations of their efficiency. It is well, however, to mention that the tige rifle, in Wisconsin, was successful for squirrel shooting by the use of a light bullet, and was of smaller calibre than those used in the French service.

The weight of the Wesson rifle, together with its appendages and care required for its loading, made it an awkward weapon for field use. The rifles and rifle barrels made by the elder Remington (the latter of which were furnished to rifle manufacturers at various localities), supplied the markets, until the breech-loaders of Colt, Sharpe and Maynard came into general use as sporting and military weapons. In regard to breech-loaders, it may be said that "Hall had patented them in 1811, and afterwards furnished 10,000 of them to the Government, which were used with success in the Black Hawk and Seminole wars, some of which remained on hand until the war of the Rebellion; that Ferguson had supplied breech-loaders to the enemy, under his command, which

were used against us at the battle of King's Mountain, in the Revolutionary war; and that, at a later date, Burnside, Jennings and others, had furnished breech-loaders to the Government for trial;" which, though not successful at the time, served as the basis upon which other companies were organized, and successful weapons were manufactured at a later date, subsequent to the war of the Rebellion, of which due notice will be taken at the proper time. From 1850 to 1860, however, Colt, Sharpe and Maynard furnished the only weapons that gained public attention, beside the European weapons which had acquired reputation during the wars of England and France with Russia (1854), and the war between France and Austria (1859).

In the year 1854, these European rifles were tried at Harper's Ferry, under orders from the war department, and experiments instituted by which the Government arms were determined upon, that were afterwards used to a limited extent in the war of the Rebellion. The 120th Regiment, N. Y. S. V. (from the County of Ulster, which the author had the honor of commanding in several engagements), were furnished with these weapons. The 20th Regiment (from the same county, in which the writer had previously served), were armed with the Enfield rifles. In the three months' service they had been armed with the smooth-bore musket.

As these trials embraced the smooth-bore musket, which, up to that time, had been the general arm, together with rifles which had been manufactured by the elder Remington for the United States Government, and breech-loaders furnished by Sharpe, it will be of interest, at this late date, to insert some of these tables, to ascertain what was the status in the knowledge of military projectiles anterior to the war of the Rebellion.

The rifles and revolvers of Col. Colt were the first successful breech-loaders and repeaters that have been made, although numerous inventions for such fire-arms are upon record for the last three hundred years. His rifles, one of which first came under the author's notice in 1843, were not at first successful; but his revolvers used in the Mexican war, gained a world-wide reputation and sale. The rifle was used by Marcy, in his overland expedition to the Red River, in 1852, and received his commendation. It was afterwards

adopted by an army board, in 1858. His patent had been obtained abroad, in England, in 1835, and at home in 1836. His first patent for revolving barrels dated back to 1830.

The Colt rifle was constructed on the same general principle as his pistols. A revolving chamber received the charges, which were either loose powder or cartridges. The charge was fired by a cap. At the outbreak of the war, it was regarded, by high authority, as "unsurpassed as a sporting weapon, and unequaled for accuracy by any military repeater. With open sights, it has placed ten consecutive shots in a nine-inch ring, at 200 yards. At 400 yards, 48 shots were successively placed in a target space four feet square; ten successive shots in a space 8x6 inches, at 200 yards, and six successive shots in a space 12x5 inches, at 400 yards. The rifle was .44 calibre, the weight of bullet was 256 grains, and of powder 36 grains."

"The Maynard rifle was first patented May 27th, 1851. A patent was obtained for a metallic cartridge in 1856, through which the fire was communicated from a cap. The Maynard cap, or primer, consisted of a narrow strip of varnished paper, of double thickness, having deposits of fulminating powder between the two, at equal distances apart. The strip containing three or four dozen of these cells was coiled in a magazine beneath the lock-plate, and brought up by the motion of a wheel in the act of cocking, so as to bring a cell directly upon the top of the nipple. The fall of the hammer exploded it, and at the same time cut off the paper behind, so that it was not seen again until the gun was cocked. The barrels were of different sizes, easily attached to and removed from the stock, one of which usually was of .50 calibre, loading 48 grains of powder and 350 grains of lead, and the other of .35 calibre, loading 36 grains of powder and 140 of bullet. In 1857 and 1858, Edward Stabler, a noted hunter of Maryland, was performing feats with this rifle, which have never been excelled for precision and celerity of fire at game. He says: 'As good, if not the best, shooting I have ever witnessed, has been done by my thirty-two-inch, small calibre Maynard. After properly arranging and adjusting the sights, and attaching a hair trigger, I have fired, with a rest, four successive balls, at 66 yards, all breaking into the first hole, and all covered by a York shilling. At 300 yards, also,

with a rest, three successive shots were all within the compass of a visiting card, or less than a two-inch ring. A year or two later (1861), a hunting companion, with me, fired at a deer swimming, at over 100 yards, and missed; before he was much, if any, over half re-loaded, I fired three balls into the same deer, killing him before he could escape.' At another time, 'coming upon two deer, within 50 or 60 yards, they standing within three or four feet of each other, I dropped the first in his tracks, and before the second had moved twenty-five yards, I had re-loaded and knocked him down also.' "

At a later date in the war, the Confederates, at Ball's Bluff, used these rifles with deadly effect.

The Sharpe breech-loader was first patented in 1848, by Christian Sharpe. A company was organized for its manufacture in Hartford, in 1851, which carried on the business there with great success. They obtained reputation during the anti-slavery struggle in Kansas. Carrying a heavier charge of powder (which was 60 grains) and heavier bullet (450 grains) than other breech-loaders of the time, it rose in favor, though its growth was a long time retarded by its imperfect cartridges and unpleasant escape of gas at the breech. The cartridges prepared for these rifles, during the war, were of stout linen, strong enough to bear rough handling; the base was of paper, through which the powder was ignited by the explosion of the cap.

In January, 1875, a new company was organized, under a special charter from the State of Connecticut. Early in 1876 the new organization erected an armory at Bridgeport, Conn., whose weapons were conspicuous in the international contests at Creedmoor and Dollymount, and whose military rifles were considered unequaled, for a time, at Creedmoor.

There were also two magazine rifles used during the war, which it is necessary to mention in this connection. The first was the Henry, with a magazine under the barrel, containing fifteen metallic cartridges. The calibre was .42; weight of ball, 216 grains, and weight of powder, 28 grains. It was afterwards merged into the Winchester rifle, whose popularity at a later date will receive subsequent mention.

The second was the Spencer repeating rifle, which was patented in the United States in 1860, and in the principal

kingdoms of Europe at subsequent dates during the same year. It was ordered in large quantities during the war, and used, among the first, the rim-fire copper cartridge. The magazine was in the butt, and contained seven charges. The calibre was .50; the charge of powder was 38 grains, and weight of bullet 450 grains. It had, also, a sporting bullet of 236 grains in weight.

The Wesson and Ballard rifles were also used during the war, both taking the copper cartridge. The latter came into more general notice at a period subsequent to the war. The other was manufactured by F. Wesson, who was formerly associated with his brother, the late Edwin Wesson, of Northboro, Mass., who is so well known in connection with the best of work in the manufacture of target rifles. The calibres of both weapons were .44, and the cartridges of each contained 26 grains of powder and a bullet of 216 grains.

General Norton, in his elaborate work on "American Inventions in Small Arms and Heavy Ordnance," gives the following list of American systems of breech-loaders, manufactured and purchased from January 1st, 1861, to June 30th, 1866, which were issued almost entirely to mounted troops:

1,509 Ballard.	20,002 Maynard.
1,002 Ball.	1,001 Palmer.
55,567 Burnside.	20,000 Remington.
9,342 Cosmopolitan.	80,512 Sharpe.
22,728 Gallagher.	30,062 Smith.
1,052 Gibbs.	94,156 Spencer.
3,520 Halls.	25,603 Starr.
11,261 Joslyn.	4,001 Warner.
892 Lindner.	151 Wesson.
14,495 Menill.	

"The conditions, whose observance is essential to the utmost perfection of accuracy and power, were more rigidly adhered to in the American target rifle than in any one which had yet been produced antecedent to the war of the Rebellion, and their fulfillment has resulted in the production of a weapon whose accuracy, probably, never can be surpassed. This weapon, weighing from twenty-five to fifty pounds with loading muzzle and telescopic sights, proved its value, under certain circumstances, during the war, having

been used by the Confederates as well as ourselves." The writer saw, at Lancaster, New Hampshire, in 1880, a couple of these weapons, with forty-pound barrels, in the shop of a gunsmith, who had been in the Confederate service during the war, and who had used them in the forts about Richmond with deadly effect.

"General Jacobs mentions, as a proof of the remarkable power of one of his rifles, that a good shot could put nearly every ball into a circle of eight feet diameter, at 1,000 yards. With the target rifle and telescopic sights, the feat has repeatedly been performed of firing a series of shots, without a single miss, into a flour barrel, at three-quarters of a mile. At Yorktown, the Andrews sharpshooters, armed with these rifles, in repeated instances held the enemy's batteries silent until counter-works were established, which could not have been erected but for their aid. On one occasion, a party of our men, working in the trenches, were annoyed by a sharpshooter, who had posted himself in a tree 800 yards distant, from which he could make their position an uncomfortable one, while it was impossible, at that distance, even to distinguish him, with the naked eye, among the branches of the tree. Two of the Andrews sharpshooters were placed in the trench, a telescopic sight was placed upon him, and the first shot brought him down."

On the 30th of June, 1863, a match, of fifty shots each, at 40 rods, was shot between a target rifle, weighing forty-two pounds, of .54 calibre, with a bullet weighing 577 grains and a charge of powder weighing 134 grains, and another gun of the same kind, with a slightly larger calibre, and with a bullet shorter than the first, but one and a half grains heavier. The fifty shots of the former measured $77\frac{13}{16}$ inches, and the fifty shots of the latter, $73\frac{14}{16}$ inches, the average, in each case, being one and a half inches from the centre. It was a very bad day for shooting, the wind blowing in violent gusts, and shifting its course continually.

"The guns were laid upon a solid frame of timber, and elevated and depressed with a screw, like artillery. Streamers of light cotton cloth, attached to poles, were fixed at intervals along the line of fire, to indicate the direction and force of the wind. The aim being adjusted, the shooter had nothing to do but watch the flags and decide upon the right

moment to pull the trigger, which he might do for himself, or direct another to do for him with equal certainty of success."

The rifles which had accomplished the victory at New Orleans, in 1816 (to which further reference will shortly be made), were generally of the type which Cooper afterwards immortalized through a succession of his novels. With barrels of $3\frac{1}{2}$ feet to 4 feet in length, weighing from nine to twelve pounds, and with round bullets weighing from 60 to 300 to the pound, the exploits of Leather Stocking, and of another hero equally familiar to the public ear as David Crockett, were performed.

In foreign countries a larger bore had been used. The general characteristics of European rifles appear to have been very large calibres, light and short barrels, and a twist of one turn in three feet, sometimes using a patch and sometimes not. In England, the barrels were $2\frac{1}{2}$ feet long, and bullets of 20 to the pound, without a patch. In 1846 the zone, or belted, rifle was introduced by Moore, a noted London manufacturer.

Grooves were first used in Vienna, in 1498, to facilitate the loading of bullets. In 1522 it had been found that giving the groove a spiral turn, relative to the axis of the bore, that greater accuracy could be obtained.

CHAPTER II.

METALLIC CARTRIDGES.

Horace Smith and Daniel B. Wesson obtained a patent in August, 1854, for the employment in a cartridge of the metallic or indurated seat, so that it shall rest directly on the powder, in combination with arranging the priming or percussion powder in rear of said disc, or on the side of it opposite to that which rests against the powder, thereby affording the opportunity for applying the force of the blow by which the priming is inflamed, such force being applied in the line of the axis of the cartridge. Under this patent they constructed, in 1859, a revolver using a central-fire metallic cartridge. In April, 1860, they also obtained a patent for a rim-fire metallic cartridge.

"Thus to the Americans is due the honor of bringing the metal cartridge to its present state of perfection, and Messrs. Smith & Wesson were the first Americans to use the copper cartridges for their pistols. The copper cartridge, for weapons of war, was first largely adopted in our own armies during the Rebellion, and was the parent of many beautiful inventions in breech-loading small arms, both in our own and other countries." In England, the first metallic cartridge cases were made from coiled metal foil, and covered with paper. They were invented in 1866, and known as the Boxer cartridge. The paper, however, rucked up when inserting the cartridge in the chamber of the gun, and has been superseded by coil brass.

For sporting guns or fowling pieces, however, non-consuming cartridges, in breech loaders, had long been used. They were invented almost simultaneously by two Frenchmen, whose inventions deserve special notice in this connection.

The first invention, though of slower growth, was eventually of the greatest importance. A. M. Pottet, in France, in 1835, invented the central-fire, non-consuming cartridge case, and his system is still the one in general use. In this cartridge the base was of metal and the cylinder of coiled paper. The base of the cartridge was filled with hard card-board, pressed into the case when it is a pulpy state. These cartridges were introduced in England in 1862.

The first gun on the central-fire principle appears to have been the Prussian needle-gun, which gun had the detonating mixture distributed over a paper wad, at the base of the bullet, the needle having to pass through the powder before it reached the detonator. It was invented by Herr Dreyse, in 1838, and adopted by the Prussian army in 1842.

To M. Lefaucheux is due the honor of inventing the modern breech-loading sporting gun; but, although, so to speak, a practically useful weapon when first introduced by him, the action was weak and imperfectly developed. But his great achievement was the introduction of a shell, or cartridge case, which should fit the breech of the gun. The shell, or case, by expanding at the moment of discharge, effectually closes the breech-joint and prevents the escape of gas. Conditions such as these had not been brought about

before M. Lafaucheux's discovery, by the combined ingenuity of his predecessors. The escape of gas was the first difficulty to be overcome, and however close the breech might be fitted, the gas would without the case, escape at the moment of firing, and find a way through the joints of the best fitting breech; its doing so was owing to the expansion of the metal. The happy idea of making the cartridge contain its own ignition greatly contributed to the success of the invention. Strictly speaking, the cartridge case is the breech and nipple of the gun, the cap being inside of the barrel; the brass striking-pin becomes the nipple; thus the objection to conducting the flash from the outside to the inside of the barrel is overcome.

The cartridge invented and used by Lefaucheux is still the same as that now commonly used in pin-fire guns. It was invented in 1836, and made of paper, with a metal base. The cap was placed into a chamber, with its cup end pointing upwards; a loose brass rod projected from the cup of the caps upwards through the cartridge case, and was struck by the hammer and driven down in the cup, thus causing the discharge.

From this cartridge may be dated the success of the modern breech-loader, for, by its expansion, at the moment of discharge, escape of gas at the breech is rendered impossible; though, if not well made, or heavily loaded, they, in common with all pin-fire cartridges, will burst at the pin-hole and allow the escape of gas through it.

The greatest advantage gained by the central-fire principle is the non-escape of gas at the breech; the next is cleanliness—there is no pin-hole in the barrels to let in the wet. The pin-hole is a great objection, as the pin must fit in the notch in the barrels, before the barrels can be closed; in very rapid loading, and during excitement in shooting, or when after dangerous game in wild countries, this would cause delay in fitting the cartridges properly. The central-fire plan greatly facilitates loading and unloading. It is often difficult to extract a tight-fitting cartridge from a pin-gun, especially when the gun is foul; this is another cause of delay. The cartridges are not so handy to carry, on account of the projecting pin, as the central-fire.

The Lefaucheux cartridge was most unsuitable for a mili-

tary rifle, on account of the projecting pin. About 1860 the rim-fire cartridge was successfully used.

The solid brass-drawn cartridge was first used in the United States. That which contained the ignition in the rim proved, upon trial, to be unsatisfactory, on account of the frequency of misfire, and liability to split and expand at the base. Moreover, it had the disadvantage that the copper shell could not be re-formed or re-loaded after the contents had been discharged.

With the rim-fire ammunition, as soon as the charge of powder exceeds 40 or 45 grains, there is danger of the shell bursting in the flange and allowing the gas to escape. The next step, therefore, in advance, was the use of the central-fire, which has a solid base the thickness of the rim, and the flange is reinforced within by an inside cup. With this cartridge we are able to use a heavy charge of powder. By concentrating the percussion composition in the centre of the head, the quantity used is reduced to less than one-fourth of what is required to prime the entire circumference in the rim-fire, and this small quantity is so much better protected as not to be at all liable to accidental explosion.

The use of this cartridge, however, with the heavy charge of powder and paper lining of the bullet, was subsequent to the war of the Rebellion, and will receive further notice.

The advantages of the metallic cartridge were its completeness and simplicity, being either self-primed or capped with great facility, and used as a whole in loading; its strength and safety, withstanding the roughest usage, and thoroughly protecting the powder and fulminate; its accuracy, because of the coincidence of the axis of the bore and the bullet; and, added to these, the impossibility of using more than one cartridge at a time. It is impervious to moisture, and may be even used after immersion in water.

CHAPTER III.

BULLETS.

The first method employed in loading the rifle consisted in forcing the bullet (spherical), either naked or covered with a greased patchin, down the muzzle, with blows of the mallet,

or with the rammer. This manner of loading deformed completely the forepart of the ball, and greatly increased its length, at the same time rendering the process of loading very slow.

The second method was loading at the breech. This consisted in giving to the part of the bore at the breech a diameter somewhat greater than the other part of the barrel, and placing in it a ball larger than the diameter of the barrel, but fitting the breech. This ball, under the action of the powder, was forced into the grooves, and had to follow them, thus getting its motion of rotation. This manner of loading was simple and easy; but the complication of mechanism the breech-loader requires, and the escape of gas at the joint, were inconveniences that prevented it from being generally applicable to arms for troops.

The third was to load by the muzzle. It consisted in giving to the ball a circular rim, which, fitting into the grooves (the rifle had but two), followed them, and thus had communicated a motion of rotation. This method did not destroy completely the windage, neither did it give any notable increase of accuracy.

None of the above methods fulfilled the conditions required of an arm for soldiers; the first being too slow, the second offering breech-loading defects, and the third not giving any marked superiority over the musket. The rifle, as an arm for infantry, would probably have fallen into disuse in Europe, and been forgotten there, had not a new method of loading been discovered by M. Delvigne, an infantry (French) officer of the Royal Guard.

The universal weapon for infantry had been the smooth-bore musket. In England, the renowned "Brown Bess," for a century and a half, was the regulation arm for the British forces. It was slightly modified for land and sea service, but the difference was trifling. It weighed 11 lbs. 2 oz. The barrel was 3 feet 6 inches long, and the bore .753 inches, or 11 gauge. The bullet used was about three sizes smaller than the bore, and was wrapped up in a loosely fitting patch, which formed a cartridge. The service charge was $4\frac{1}{2}$ drachms (122 grains), with a bullet of 490 grains.

The calibre of the United States musket was .69. Its service charge was 110 grains, and weight of ball 400 grains. The initial velocity was 1,500 feet per second.

The method of Delvigne for loading the rifle with a spherical ball, consisted in screwing into the lower end of the barrel a hollow breech, the diameter of which was a little less than the diameter of the barrel, forming thus a chamber in the bottom of the piece, in which the powder could be deposited, and a projection, or shoulder, upon which the cartridge could rest. The cartridge was composed of a sabot of wood, hollowed out spherically on its upper side, and having about its inferior part a patchin of greased serge. The sabot, resting on the shoulders of the chamber, gave to the ball a fixed support, which permitted the person loading to flatten it slightly, by means of a few gentle taps of the rammer, thus forcing the lead into the grooves; the shoulders of the chamber prevented the ball from penetrating it, and thus made its expansion into the grooves regular; the patchin served to prevent the inconvenience of fouling; and, finally, the grease, melted by the inflammation of the powder, formed, with the residuum, an unctuous paste which offered no resistance to the descent of the ball in loading, and which was, in part, thrown out by the discharge.

The contrivance of Captain Delvigne, without the sabot, was first introduced in 1826, and tried two years in the Garde Royale, during the expedition to Africa, in 1830, and was found still defective. The edge of the chamber on which the bullet lodged, not being opposed to the direction of the blow with the ramrod, did not form a sufficient support upon which to flatten the bullet, whilst, after a few rounds, a foulness formed in the chamber and on the outside of it; sometimes, also, a portion of the charge of powder, when poured in, having lodged on the contraction, cushioned, and caused the bullet, instead of resting on the edge of the chamber, to rest on the powder, so that it was no longer really forced into the grooves; consequently, the latter, becoming foul, could not, in their turn, any longer act effectively on the bullet. Besides, the military authorities in those days would not hear of an elongated projectile; hence arose another objection; for, if the spherical bullet was rammed too hard, part of the lead was forced into the chamber, thereby lengthening the projectile and throwing its centre of gravity out, so that it turned over on the axis of its smallest amount of inertia, and the accuracy became greatly affected at 220 yards.

M. Delvigne's fundamental principles were, however, too important to be passed over with neglect, and his rifle was submitted to an artillery committee for further improvement. By this committee (of which Lieutenant-Colonel de Poncharra, of the engineers, was president), greased cartridges were adopted, which, introduced with the bullet, cleaned the groove each time; and the ball was further made to rest on a wooden cup, or sabot, which, fixed to it, rested on the top of the chamber.

The Poncharra-Delvigne rifle, although answering exceedingly well in the practice carried on within France and Belgium, in 1839, was still objectionable as a war weapon, from the complication in the ammunition, causing the latter to be procured with difficulty in the field. M. Delvigne then proposed a rifle musket; but, about the same time, the commandant of the French artillery (Thierry), presented another model of a rifle, from which cylindro-conical bullets were to be fired; and these M. Delvigne had proposed should be flat at the bottom, the body cylindrical, and a conical point. Although tried on a large scale, they were not found to answer with the Thierry rifle, and were replaced by spherical bullets.

Colonel Thouvenin, of the same service, then endeavored to overcome the difficulties which the Delvigne rifle presented, by fixing at the bottom of the bore an iron shank, having an axis identical with that of the bore, and around which was placed the powder; the shank, stopping the bullet, allowed it to be struck in such a manner as to cause the lead to penetrate into the grooves. But here another defect appeared. The pillar occupying a large portion of the centre of the barrel, and the charge being placed in the annular space surrounding it, the main force of the powder, instead of taking effect in the axis of the piece and in the centre of gravity in the projectile, acted only on that spherical portion of it which lies over the annular chamber, and thus the bullet, receiving, obliquely, the impulse of the charge, was propelled with diminished force. Colonel Thouvenen's rifle was thus about to share the fate of M. Delvigne's, when it was considered advisable to try it in connection with the elongated bullet already proposed.

Captain Delvigne, as we have seen, had proposed the

adoption of lengthened bullets, consisting of a cylinder terminated by a cone, which was subsequently replaced by an ogive, and he had further obtained a patent, dated 21st June, 1841, amongst other matter, "For having hollowed the base of my cylindro-conical bullet, not only for motives mentioned in the descriptive memoir, given with my demand for a patent, but, besides, to obtain its expansion, by the effect of the gases produced through the ignition of the powder. By this means the efforts of the powder itself, which formerly caused spherical bullets to deviate from the grooves, now contributes to force the bullets of my system more firmly into them."

In a paper published by M. Delvigne, in the "Spectateur Militaire," of August, 1843, we find: "But during these investigations, I made an important discovery, which was, that the gas, produced by the ignition of the powder, rushing into the vacuum formed at the base of the bullet, expanded it and forced it into the grooves. I here give the idea—a new one, as I think—and recommend its application to such as occupy themselves with the effect of fire-arms and powder. The following, however, must be avoided: if the hollow is too deep, the expansion is too great, and the consequent friction enormous; sometimes, even, the gas will traverse the bullet, and, consequently, the projectile is deprived of a proportionary amount of velocity; if too small, the expansion does not take place."

Captain Minie, an instructor in the school of Vincennes, merely filled up this hollow with an iron cup. This prevented the gas forcing its way through the lead, and the iron pressing on the lead increased the expansion.

It was then considered that a practical and definite solution had been obtained, which would enable soldiers to be armed with a more useful weapon, firing a cylindro-ogival bullet, having a groove in the cylindrical part, intended to receive a greased patch; at one time this was thought to be useless. People were then surprised to find that the firing lost much of its accuracy, and the groove was replaced, when it was discovered that any variation in its shape and in its position materially affected the practice. Not only variations in the groove caused great alteration in the accu-

racy of the fire, but any modification bearing on the trunk of the cone, in rear of the projectile (for it was not quite a cylinder), or on the fore ogive, altered the conditions of the firing, so that the groove became, as it were, lost in the midst of many other principles, the functions of which were as much unknown. These theoretical considerations served, however, as a point of departure for further investigations.

Captain Tamisier, another instructor in the school of Vincennes, intrusted with following up the facts, and connecting them by theory, had not ceased, for several years, concentrating his entire attention on the subject.

The groove had deprived the bullet of all geometrical form. M. Tamisier wished to study the simple form, and tried the pure cylindro-conical shape. He successively varied the length of the cylindrical part and the angle of the cone.

The difference between a conical and cylindro-conical bullet, in practice, is found in the fact that the former will not naturally lie in the barrel as it should do, so that the axis of the one may be coincident with the axis of the other, but will lie at an angle, and, on leaving the barrel, when inclined to one side, the inflamed gunpowder is enabled to escape at the muzzle, on one side of the ball, before the other is out of the barrel, thus giving the bullet a tendency to deviate from its true path.

Having found that these variations greatly influenced the accuracy of the firing, Captain Tamisier sought out the reason. The conclusion he came to was that, to increase the precision of elongated bullets, it was necessary to ascertain the means of giving them a point of resistance, as far as possible, behind their centre of gravity. His first endeavor was to carry this centre of gravity to the furthest possible point forward; but to effect this, he was compelled to flatten the fore end of the bullet, which had the disadvantage of increasing the resistance of the air to the movement of projection. On reflection, he was led to adopt another plan for rectifying the path of the bullet through each instant of projection; and this was by creating, at the posterior end, resistances which should act in case the axis of the bullet did not coincide with the direction of motion, and this was carried out by cutting upon the cylindrical part, instead of one as many

circular grooves of .28 inches in depth as that cylindrical, or, rather, slightly conical, part could contain. An increased precision of firing, was the immediate result.

It is well to remark that the idea of carrying the centre of gravity forward, had not escaped the penetrating mind of Robbins, who proposed to overcome the deviation of spherical bullets, by making them of an egg-like form, "For, if such a bullet," says he (Mathem. Tracts, vol. 1, p. 338), "hath its shorter axis made to fit the piece, and it be placed in the barrel with its smaller end downwards, then it will acquire, by the rifles, a rotation around its larger axis; and its centre of gravity lying nearer to its fore part than its hind part, its larger axis will be constantly forced, by the resistance of the air, into the line of its flight; as we see that, by the same means, arrows constantly lie in the line of their direction, however that line be incurvated."

Colonel Beaufoy, in a very excellent little work published in 1812, remarks upon this: "Several experiments have been tried with the egg-shaped ball, recommended by Mr. Robbins, as preferable to the spherical form usually adopted, the general results of which are nearly as follows: At long distances—that is, from 300 to 600 yards—when fired with a gun of $\frac{6}{10}$ of an inch bore, they were found much less liable to deviation than at 200 yards and under, with this peculiarity, that in windy weather, whereas balls are usually driven to leeward of the object, these had a diametrically opposite effect. It was found, however, that these balls were subject to such occasional random ranges, as completely baffled the judgment of the shooter to counteract their irregularity. Their deviations to windward, most likely, arose from the effect of the wind on the after part, which, as being the lightest end of the two, was driven more to leeward, and, consequently, acted as a rudder to throw the foremost end up in the wind."

That these grooves have the effect of improving the accuracy of firing when the bullets are not perfectly homogeneous, is certain; but the British committee on small arms justly considered that, owing to the careful way in which the bullets are made in England, by compression, these grooves might be dispensed with, and also that such a form might be given

to M. Delvigne's hollow at the base of the bullet as would obviate the use of the iron cup.

Balls were made by pressure in England, in 1838. In France, however, at the time of which we are writing, they were molded.

With these objects in view, Lord Hardinge, in 1852, requested the leading English gun-makers to lay before the Small Arms Committee such suggestions as they might consider would effectually improve the projectile then in use, as well as the arm. No bullet, however, was submitted which was not a compound one—that is to say, having either a separate plug, or an iron or copper cup, to produce the required expansion—except one, by Wilkinson, of Pall Mall, which had, however, the defect of losing its accuracy when made up into cartridge, as two very deep grooves, round its lower part, closed up, by the force of the powder, and nipped the paper round it, and held pieces of it during its flight, thus causing very wild practice beyond 300 yards. But, after the several trials were over, a bullet was submitted by Mr. Pritchett, of St. James Street, consisting of a simple cylindro-conoidal projectile, having a small hollow at the base. The expansion of this bullet is obtained by its being made of such a length, in proportion to its diameter, that the force of the powder, when ignited, acting suddenly against the base, driving it up slightly before the inertia of the point of the bullet is overcome, thus causing it to expand throughout its cylindrical part, and more especially at the shoulder, the most important part being directly over the centre of gravity, the hollow at the base being more with the view of lightening the bullet, and throwing its centre of gravity forward, than to obtain expansion by its means.

The shooting of this bullet, up to 800 yards, was found superior to any that had yet been tried, when loaded according to the usual Minie style, with greased cartridges reversing the bullet. A satisfactory solution was then supposed to be arrived at; but, owing to the difficulty of loading after fouling, which was so seriously complained of in the Crimea, the whole question of the projectile was reopened, and a bullet was substituted with a deeper hollow, and a wooden cup, which became the regulation service bullet.

The writer from whom we have been quoting (Captain Jervis, in 1859) goes on to say: "I have carefully abstained, throughout this work, from offering any opinion of mine own upon the various suggestions or trials which have been made at different times, respecting any part of the musket rifle; but as this bullet, with a wooden cup, is a decidedly retrogressive movement in the science of gunnery, I shall make one or two remarks.

"When the Crimean war broke out, the practical application of the theory of projectiles was in its infancy, and numerous features remained to be demonstrated, and, amongst others, 1st, the amount of windage required; 2d, the manufacturing of the cartridge. Now, as, according to the theory of expansion, there was only the difference of .01 allowed between the width of the bullet and the diameter of the bore, and even this space was taken up by the paper of the cartridge, which was greased around the bullet so as to lubricate—that is to say, clean the barrel each time it was loaded; but, nevertheless, it was found that, in hot weather, fouling would take place to considerable extent, and at the same time, the grease around the cartridge evaporating from the same cause, the bullet, after some twenty rounds, got forced through the paper of the cartridge, and after some rounds could not be forced down at all. This was a serious question, and, after due deliberation, the fault was laid to the Pritchett bullet, and the Minie was restored, a boxwood plug being substituted for the iron cup. But an important fact had been overlooked, which was, that owing to the cup, the paper of the new cartridge was always carefully tied at the base of the bullet, to prevent the plug falling out, and that it was this tie (termed a choke) which prevented the bullet forcing its way through the paper, and that, had it been continued with the Pritchett bullet, it might have answered as well. However, this new projectile did not do away with the real difficulty of loading when the barrel fouled; and it has been found necessary to diminish the diameter of the bullet to .551, a wise and judicious step, which, though it may slightly affect target practice, will afford most important results in the field, where facility of loading is of paramount importance."

These are sagacious remarks, and there is no doubt but that, with the present cartridge, the Pritchett bullet even now would make good work at the butts, and prove to be a good military bullet. But it is necessary to pass on to other considerations, to see the Pritchett bullet experimented on unsatisfactorily by our own army officers. We quote now from them:

The rifle with the stem (carabine a tige), model of 1846, had a calibre of .676 inches. Its ball weighed 717 grains, and its charge of powder was 64.8 grains. In the essential requisites of length of range and accuracy, it far excelled all arms heretofore tried. At 1,421 yards, the cylindro-conical ball struck the target point first, passing through two targets of inch poplar plank, and indenting the third.

The rifle a tige, as a weapon, seemed brought to perfection, or in other words, the range, accuracy and simplicity of this arm seemed as perfect as possible, when a new invention, by Captain Minie, gives us not a greater range or accuracy, but greater simplicity in construction and loading. The ball was fired from the same rifle, the tige being removed. The report, from which these items are extracted, was made in Paris, in 1851.

In England, in 1852, the following experiments were made with small arms:

The following principal gun-makers offered arms to the Master-General of Ordnance, which, as well as the Minie rifle adopted in 1851, and the regulation two-grooved rifle, were experimented on, being fired from a frame arranged for the purpose. All the makers proposed bores and bullets as follows:

Mr. Purdy	.650	inch bore, or	17	balls	to the	pound.
Mr. Lovell	.625	"	18	"	"	"
Mr. Greener	.621	"	19	"	"	"
Mr. Richards	577	"	24	"	"	"
Mr. Lancaster	.540	"	30	"	"	"
Mr. Wilkinson	530	"	31	"	"	"
Regulation Minie	.702	"	13	"	"	"
Brunswick	.704	"	13	"	"	"

Distances for fall of ball, 4 feet $7\frac{1}{2}$ inches.

	Yards.	Feet.	Inches.
Lancaster	194	0	11
Lovell (heavy ball)	190	0	5
Lovell (light ball)	176	1	$6\frac{1}{2}$
Wilkinson (naked ball)	185	0	$3\frac{3}{10}$
Purdy (plug ball)	180	2	4
Regulation Minie	177	1	7
Brunswick (rifle)	173	0	$2\frac{1}{4}$
Wilkinson (cartridge)	172	1	$5\frac{1}{2}$

Yards.	Regulation-Minie.—Twist, 1 in 6½. Powder, 68 grs. Bullet, Minie; length, 1.03 in.; diameter, .69; weight, 680 grs. Angle elevation.	Wilkinson.—Twist, 1 in 6.6. Powder, 68 grs. Bullet, solid expanding; length, 1.075 in.; diameter, .537; weight, 500 grs. without patch, grooves greased. Angle elevation.	Lancaster.—Smooth-bore and elliptical, increasing spiral. Powder, 68 grs. Bullet, expanding by plug; length, 1.125 in.; diam., .532; weight, 542 grs. Angle elevation.	Purdy.—Twist, gaining to 1 in 4.6. Powder, 68 grs. Bullet, plug; length, 1.05 in.; diameter, .643; weight, 610 grains. Angle elevation.	Lovell.—Twist, 1 in 6.6. Powder, 68 grs. Bullet, Minie; length, 1.145 in.; diameter, .63; weight, 686 grains. Angle elevation.	Brunswick.—Twist, 1 in 2.6. Powder, 68 grs. Bullet, spherical belted; diameter, .696 in.; weight, 557 grs. Angle elevation.	Enfield.—Twist, 1 in 6.6. Powder, 68 grs. Bullet, solid expanding; length 0.960 in.; diameter, .568; weight, 520 grs.
100	0.14	0.14	0.11	0.15	0.11	0.08	0.13
200	0.39	0.28	0.26	0.40	0.26	0.34	0.27
300	0.53	0.47	0.49	0.57	0.49	0.54	0.43
400	1.22	1.05	1.09	1.17	1.09	1.26	1.
500	1.51	1.25	1.34	1.47	1.34	Too wild to give a correct angle.	1.19
600	2.23	2.	2.02	2.21	2.02		1.40
700	3.05	2.29	2.32	2.58	2.32		2.03
800	3.25	2.44	3.01	3.41	2.50	.....	2.29
900	.....	.....	.....	.....	.....	.....	2.57
1000	.....	4.31	.....	.....	4.16	.....	3.28

Comparison of Percussion Musket of 1842 with Minie Rifle of 1851:

Distances. Yards.	Musket. Bullseye.	Rifle. Bullseye.	Musket. Centres.	Rifle. Centres.	Musket. Outers.	Rifle. Outers.	Musket. Total Hits.	Rifle. Total Hits.	Musket. Per Cent.	Rifle. Per Cent.
100	7	10	48	68	94	111	149	189	74.5	94.5
200	3	9	20	47	62	104	85	160	42.5	80.
300	4	6	20	32	17	72	32	110	16.	55.
400	2	5	0	29	7	71	9	105	4.5	52.5

Returning to the trial of arms that was made at Harper's Ferry, in 1853 and 1854, we shall first record the result of the trial of the smooth-bore percussion musket then in general use.

"To give the spherical ball heretofore used a fair trial, on equal terms, a new musket of the exact calibre was fitted with the same breech sight, or guide, used on the rifles a tige, and fired from the same rest, and with every precaution necessary to insure accuracy.

The annexed table of the firing shows that, at 300 yards, the musket is not as accurate as the new rifle bullet at double the distance; and at 400 yards, the fire of the musket is so uncertain as to be useless:

TARGET PRACTICE AT 300 YARDS. PERCUSSION MUSKET, SERVICE CHARGE.

Size of Target	No. of Shots fired.	Mean Perpendicular Deviation.	Mean Horizontal Deviation.	Mean Absolute Deviation.	REMARKS.
30x15	25	42.04	70.75	87.06	12 per cent. missed target.

AT 400 YARDS.

Size of Target	No. of Shots fired.	Mean Perpendicular Deviation.	Mean Horizontal Deviation.	Mean Absolute Deviation.	REMARKS.
30x15	25	51.90	51.50	68.20	80 per cent. missed target.

To compare the spherical ball with the new elongated ball in the rifle, a supply of rifle cartridges was procured at the Washington Arsenal, and fired from the same rifle used in the trials with the elongated ball. The annexed table gives the result of these trials, which show that the limit of accuracy with the spherical ball is between 200 and 300 yards; over this latter distance it fails entirely.

The regulation rifle thus used had a diameter of bore of 0.54; of barrel at breech, 1.15; at muzzle, 0.90; with a length of 33 inches, and a weight of 5 lbs. 5 oz. The length of the arm was 48.8 inches, and weight 9 lbs. $10\frac{3}{4}$ oz. It had 7 grooves, 11 inches wide and .02 in depth at breech, and same

depth at muzzle. Its twist was regular, with one turn in 6 feet.

The weight of the service charge of the regulation musket was 110 grains, and weight of bullet 397.5 grains, and the initial velocity of the bullet was 1,500 feet per second.

The weight of the service charge of the regulation rifle was 70 grains, and the weight of its spherical bullet was 217 grains. Its initial velocity was 1,750 feet per second.

TARGET PRACTICE WITH REGULATION RIFLE, SERVICE CHARGE, SPHERICAL BULLETS.

Distance to Target.	Size of Target	No. of Shots fired.	Mean Perpendicular Deviation.	Mean Horizontal Deviation.	Mean Absolute Deviation.	REMARKS.
150 yds.	8x8	25	7.24	6.16	10.53	7 shots in bullseye. 3 missed target.
200 "	8x8	25	12.13	13.27	19.67	1 shot in bullseye.
300 "	8x8	25	15.58	32.03	39.	19 shots missed target. 76 per cent

TARGET PRACTICE WITH SHARP'S CARBINE. TABLE OF MEAN DEVIATIONS. TARGET, 8 x 8 FEET.

Distance to Target.	No. of Shots fired.	Mean Vertical Deviation.	Mean Horizontal Deviation.	Mean Absolute Deviation.	Shots missed Target.	DATE.
150 yds.	25	10.12	7.71	13.78	1	Feb'y 14, 1854.
200 "	20	15.08	9.15	19.95	1	March 6, 1854.
300 "	20	23.96	7.94	27.29	4	March 9, 1854.

REMARKS.

The bullets are too large for the diameter of the chamber of the barrel. After being fired four or five rounds, it was found impossible to force the cartridge in without bursting it and spilling the powder. The firing was continued by resorting to the expedient of separating the bullet from the cartridge, forcing it into the chamber with a stick, and afterwards pouring in the powder. The slide frequently became very difficult to move. When the arm was taken in the shop to be cleaned, after the firing was concluded, the slide could not be moved at all, until thoroughly soaked in oil to soften

the dirt around it. The paper of the cartridge is always left behind in the chamber, after each shot, and is frequently on fire when the succeeding cartridge is inserted. To remove all likelihood of danger from this, the paper remaining in the chamber, after each shot, was removed before inserting another cartridge.

Experiments conducted for a couple of years, at Harper's Ferry and Springfield Arsenals, which embraced the prominent European rifles and bullets, in July, 1855, the following calibres were established :

.69 inch.....Rifle-musket, model 1822, altered.
.69 " ..... " " 1842, "
.58 " ..... " " 1855, "
.58 " .....Rifle, " 1841, new.
.58 " ..... " " 1855, "
.58 " .....Pistol-carbine, " 1855, "

TRAJECTORIES.

Yards.	New Rifle-musket. Bullet, 500 grs.; Powder, 60 grs.	Altered Rifle. Bullet, 500 grs.; Powder, 60 grs.	Altered Musket. Bullet, 730 grs; Powder, 70 grs.
200	0.20	0.25	0.30
300	.40	.50	1.
400	1.05	1.10	1.30
500	1.30	1.45	1.50
600	2.00	2.10	2.15
700	2.20	2.35	2.50
800	2.50	3.00	3.15
900	3.30	3.40	4.10
1000	4.15	4.30	4.50

PENETRATION OF SEASONED WHITE PINE PLANK, 1 INCH THICK $1\frac{1}{2}$ INCHES APART.

Yards.	New Rifle-musket. Bullet, 500 grs.; Powder, 60 grs.	Altered Rifle. Bullet, 500 grs.; Powder, 60 grs.	Altered Musket. Bullet, 730 grs.; Powder, 70 grs.
200	11	$9\frac{1}{3}$	$10\frac{1}{2}$
600	$6\frac{1}{2}$	$5\frac{2}{3}$	$6\frac{1}{3}$
1000	$3\frac{1}{4}$	3	$3\frac{1}{2}$
Initial velocity.....	963	914	880

TABLE OF MEAN DEVIATIONS FOR NEW RIFLE-MUSKET. TARGET 16 x 24. WEIGHT OF BALL, 500 GRAINS. WEIGHT OF POWDER, 60 GRAINS.

100 yards	.....	1.9	inches	vertical.	1.5	inches	horizontal.
200 "	.....	4.4	"	"	3.8	"	"
300 "	.....	5.5	"	"	5.1	"	"
400 "	.....	9.1	"	"	8.8	"	"
500 "	.....	13.6	"	"	17.1	"	"
600 "	.....	22.2	"	"	14.6	"	"
700 "	.....	30.6	"	"	14.4	"	"
800 "	.....	39.6	"	"	21.	"	"
900 "	.....	34.8	"	"	21.4	"	"

POINTS OF TRAJECTORY NEW RIFLE-MUSKET, U. S. DISTANCE, 200 YARDS. WEIGHT OF BALL, 500 GRAINS. WEIGHT OF POWDER, 60 GRAINS.

Height, inches	14.5	17.7	19.3	19.6	17.5	10.
Distance, yards	50	75	100	125	150	175

POINTS OF TRAJECTORY OF ALTERED MUSKET, U. S. DISTANCE, 200 YARDS. WEIGHT OF BALL, 730 GRAINS. WEIGHT OF POWDER, 70 GRAINS.

Height, inches	16.2	18.8	19.7	20.9	17.5	10.4
Distance, yards	50	75	100	125	150	175

POINTS OF TRAJECTORY HARPER'S FERRY RIFLE, U. S. DISTANCE, 500 YARDS. WEIGHT OF BALL, 400 GRAINS. WEIGHT OF POWDER, 50 GRAINS.

Height, inches	.85	1.41	1.45	1.50	.97	0
Distance, yards	100	200	250	300	400	500

This was the rifle made by Remington for the spherical ball of 219 grains, and weight of powder, 70 grains. Altered as above to use an elongated ball.

The highest point of the 100 yards trajectory for the pistol carbine was 12 inches; and the highest point of the 300 yards trajectory for the rifle-musket was 40 inches.

A strong wind blowing perpendicularly to the direction of the rifle-musket ball, will deflect it from its course 12 feet in 1,000 yards, about 3 feet in 500 yards, and about ½ foot in 200 yards.

TRAJECTORY OF THE ENFIELD (ENGLISH) RIFLE AT 100 YARDS. WEIGHT OF BULLET, 520 GRAINS; OF POWDER, 62¼ GRAINS.

Distance from Muzzle, yards	50	75	100
Height of Bullet, inches	9	6¾	0

AT 200 YARDS.

Distance, yards	50	75	100	125	150	175	200
Height, inches	11½	14½	19	21	20½	10½	0

AT 300 YARDS.

Distance, yards	50	75	100	125	150	175	200	225	250	275	300
Height, inches	17½	26½	33	40 7/12	42½	43	39	32	24	14	0

MEAN VARIATIONS REFERRED TO MEAN POINT OF IMPACT OF 100 SHOTS FIRED.

	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.	Yds.
Distances ...	164	273	382	437	546	656	765	874
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Minie.	24.40	33.87	46.37	47.63	59.44	104.74	109.44	129.11
A tige	24.80	38.20	59.37	48 03	69.68	115.35	137.40	137.40

In the month of June, 1849, these new balls were thoroughly experimented upon at Vincennes. All the comparative trials of this bullet, and the elongated one with the "a' tige" rifle, were made, firing off-hand at different distances.

The graduation of the hausse for the Minie rifle was not quite so high for the same distance as for the "a' tige."

Comparison of the Infantry Musket and Musket Altered "A' Tige."

Distances to and Dimensions of Target.					No. of Marksmen.	No. of Balls fired.	Infantry Musket.	Infantry Musket altered to Rifle "A Tige."
Yds.	Ft.	In.	Ft.	In.			Hits.	Hits.
164	6	6 x	1	10½	15	60	18	37
218	6	6 x	4	8½	15	60	21	45
437	6	6 x	6	6	15	60	3	31
656	6	6 x	13		15	60	3	25
874	6	6 x	19		15	60	3	14

Range.	Time of Flight.			Range.	Time of Flight.		
Yards.	* Rifle 1842. Seconds.	Wallpiece. 1842. Seconds.	† Rifle A' Tige. Seconds.	Yards.	Rifle 1842. Seconds.	Wallpiece 1842. Seconds.	Rifle A' Tige. Seconds.
165	0.42	0.46	0.50	765	....	....	2.97
218	0.74	0.75	0.69	874	....	....	3.67
328	1.29	1.37	1.13	984	....	....	4.35
437	1.75	1.73	2.44	1093	....	....	5.07
546	2.64	2.53	1.86	1202	...	....	5.81
656	....	4.40	2.37	1312	....	....	6.71

* Round ball; 517 grains; initial velocity, 1,408 feet per second.

† Cylindro-conical ball; 725 grains; initial velocity, 1,023 feet per second.

The annexed table gives the mean results of many trials made at Vincennes. The piece was loaded with as great regularity and care as possible, and was fired from a stand which held it at each discharge in exactly the same direction.

Mean Deviations of Carbine A' Tige.

Distances of the Target.	Mean Horizontal Deviation.	Mean Vertical Deviation.	Distances of the Target.	Mean Horizontal Deviation.	Mean Vertical Deviation.
Yards.	Inches.	Inches.	Yards.	Inches.	Inches.
165	4.72	5.11	656	21.26	22.04
218	7.87	8.26	765	24.40	29.52
328	11.02	11.81	874	29.52	39.37
437	12.59	13.77	984	37.40	59.51
546	17.32	17.71	1093	49.21	82.67

MEAN DEVIATIONS OF MUSKET ALTERED TO RIFLE A' TIGE.

Distances of the Target. Yards.	Mean Horizontal Deviation. Inches.	Mean Vertical Deviation. Inches.	Distances of the Target. Yards.	Mean Horizontal Deviation. Inches.	Mean Vertical Deviation. Inches.
164	5.90	6.30	546	19.29	20.86
279	9.44	9.84	656	24.40	26.37
382	13.	13.77	765	30.31	35.43
437	14.96	16.14	874	37.40	47.24

Shortly after the introduction of the Brunswick (belted ball) rifle, the Minie rifle was produced, and his principle adopted by the British government, who gave M. Minie £20,000 for his invention.

NOTE.

In closing the space allotted to the first part of this work on rifle practice, it is well to remark that the next number will continue the description of the Whitworth, Lancaster and Jacob bullets, which were all brought out anterior to our civil war. It will then take up a resume of the lessons taught by that war, and commence a description of Peabody, Remington, Winchester, Sharp, and other rifles, and their work, which will be continued throughout the third number, taking in a description of the improvements in shells, and more particularly the Berdan shell and bullet. The fourth number will be devoted to the express and elephant rifles, and incidentally to the choke-bore gun which was preeminently an American invention. The fifth number will be devoted to the development of the match and military rifles, particularly at Creedmoor, Dollymount and Wimbledon. The last number will be devoted to the improved cartridges, which logically grow out of this discussion, and to their tabular performances, when fired from different weapons—from the elegant match rifle down to the cheapest form of military rifle. These cartridges for military purposes will be of three kinds.

1st. A cartridge, to be fired from a rifle, with the ordinary fixed sights, containing a very high charge of powder and a light bullet, to be used within a range of 500 yards, with a very low trajectory and unsurpassable accuracy, extreme range 1,800 yards.

2d. A cartridge, with less powder, but heavy bullet, to be fired from the same rifle, with a fine sight, which can readily be attached to or detached therefrom, which will cover from 500 to 1,500 yards with extreme accuracy, extreme range beyond two miles.

3d. A cartridge, containing a heavy explosive bullet, to be fired from the same rifle, with a range of two miles.

The elliptical targets and bulls-eyes ordered to be used in the army will receive particular attention. It is an understood fact that they are rendered necessary by the excess of vertical over horizontal discrepancies in the use of the Springfield rifle, a fact which may be verified by a glance at the tables which have been already introduced; and a fact that will always be established by using 70 grains of powder in any rifle at long range; it is also an undoubted fact that the Springfield bullets

differ in their initial velocities from ten to fifteen feet a second, because the bullets of match rifles have been found to vary more than that by Greener's experiments; yet it is also a fact established by the records of Creedmoor, of the match for the Leech Cup, on July 4, 1884, a fact which was also witnessed by the writer, who will testify that it was a windy and stormy day, that more than half of the rifles engaged in that match made full scores at 800 yards, and that one rifle made 43 bulls-eyes out of 45 shots, equally distributed at 800, 900 and 1,000 yards. Here, though there were varying initial velocities of 25 feet a second, yet there was no need of elliptical targets, and if the Springfield rifle could be made to contain a cartridge loaded with 110 grains of powder, the necessity for elliptical targets for that weapon would disappear.

A large space will be devoted to the consideration of hollow bullets, of which the author has made a specialty.

Early impressed with the importance of flat trajectories, we have sought to realize them from hollow bullets, as only in their use the length of bullet and lightness of projectile can be obtained. We have seen that they have been in use for a long time, for explosive shells and express rifles, but curiously enough they have only been used with light twists to the grooves, probably because the superiority of their spinning, furnished, with this light rifling, all that would be required for accuracy in the short distances, for which they were to be used. It was probably supposed that the quick twist of the long-range rifle would deaden the velocity, which was the essential thing sought for in an express rifle. So we read in Greener's books of 125 yards and 150 yards of point-blank range, of the express rifles, conveying the idea that for this distance the bullet, from its extreme velocity, would keep upon a ~~target~~ tangent without any curvature. It is unnecessary to refute this absurd notion, and we dismiss the attempt with the single remark, that in none of the velocities of the express bullets, which he has recorded, would the fall of the bullet, in 150 yards, be less than one foot measured upon the target, and that with this declination, raising the back sight above the front .08 of an inch, in the distance of 3 feet between sights, would accomplish this point-blank, without a deviation of over 3 inches when aimed at an intermediate object.

As to the statement that hollow bullets, though of unsurpassable accuracy at short distances, go wild after traversing a distance of 250 yards, we have this to say, that they could not have been of a proper length or fired from a proper twist. We have them of all sizes and weights, and are prepared to state that they can be fired at long range with accuracy. Of course, they are varied by the wind more than solid balls, but the accuracy of their flight is greater, until we reach, in the solid bullet, the prescribed length of three diameters. When we have reached this length, the weight of the bullet is too great for flat trajectory from a military rifle.

The material for the successive numbers of this work is prepared, and will appear in print as rapidly as circumstances will allow.